Commissioning a secured bottle to transfer highly radioactive solutions between two hot cells in ATALANTE facility
Part 1 - CEA Marcoule research center and ATALANTE facility
10 Research centers in France

Commissariat à l’énergie atomique et aux énergies alternatives

Elodie CHEUTET – HOTLAB 2019
Construction from 1985 to 1992, then from 1995 to 2000

Commissioning of laboratories and shielded lines from 1992 to 2005, then in 2009 and 2018
THE R&D HOT-LAB DEDICATED TO FUEL CYCLE

I – Actinides and Fission Product Basic Chemistry

II – Spent fuel dissolution

III – Extractant molecule design

IV – Separation processes

V – Conversion Processes

VI – Actinide-bearing compound fabrication

VII – Conditioning, long-term behavior

VIII – Analyses

Recycling

Waste Conditioning

Spent fuel processing

Research engineers and technicians involved in research work, including more than 30 young trainees

CEA employees responsible for operation of the facility (conventional and nuclear safety, liquid and solid waste management, maintenance operations)
ATALANTE facility

- **17** laboratories for working with radioactive materials in 250 glove boxes
- **9** shielded lines dedicated to research on very high activity materials, including 50 workstations with telemanipulators
- **1** organic liquid waste treatment unit
- **1** waste drum radioactivity measuring station
- **2** shielded lines for managing liquid and solid waste in the facility

19 000 m² of floor space
Part 2 – Commissioning a secured bottle in ATALANTE facility
Why do we need it?

- To transfer between two hot cells a few liters of aqueous solutions that are valuable in the process.

3 existing ways for transfer between to hot cells:

- **Pneumatic transfer**
  - Volume to transfer too big

- **Pipe line**
  - Volume to transfer too small / distance

- **Container**
  - Adapted only for solid material

Need to create a specific system that can be used in ATALANTE facility.

<table>
<thead>
<tr>
<th>Solutions from fuel dissolution</th>
<th>Age (years)</th>
<th>Acidity (M)</th>
<th>Activity α (GBq/L)</th>
<th>Activity βγ (GBq/L)</th>
<th>Volumetric thermal power α (W/L)</th>
<th>Volumetric thermal power βγ (W/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UOX</td>
<td>3</td>
<td>3</td>
<td>290</td>
<td>14300</td>
<td>0.270</td>
<td>1.370</td>
</tr>
<tr>
<td>MOX</td>
<td>3</td>
<td>3</td>
<td>270</td>
<td>18500</td>
<td>1.240</td>
<td>1.050</td>
</tr>
</tbody>
</table>
What is it?

Equipped and produced in conformity with the European Community technical rules (PED 97/23/EC)

Characteristics:

- Dimensions:
  - 400 mm high
  - 200 mm diameter
- Stainless steel 316L:
  - 4 mm thickness
  - 8 density
- Volume: 7 L
- Weight: 16 kg
- Operating pressure: 20 bar
How does it work?

- **Filling** the secured bottle in shielded line A:
  - from a vessel via a pot for accurate measurement of the volume
  - or with flasks by means of a funnel
- **Transfer** of the secured bottle from shielded line A to shielded line B within 10 hours to respect the time limit for radiolysis constraints
- **Emptying** of the secured bottle in shielded line B
- **Retransfer** of the secured bottle from shielded line B to shielded line A
- **Rinsing and storage** in shielded line A
How does it work?

Transfer between two hot cells

Secured bottle

Container

Cask

< 2 mSv/h
Schedule step by step: from design studies to commissioning in hot cells

Design studies

Inactive tests

Safety file

Commissioning in hot cells

NSA authorization
1 – Design studies
Operation requirements

- It must not lead to any major modification to the structures of the shielded lines
- **Operation requirements**
  - It must be handled in hot cell and usable with master-slave manipulators
Safety requirements

- It must ensure containment of nuclear material
  - ✓ avoid a leak in the container that is not designed to carry liquids
  - ✓ maintain containment in the event of a fall
  - ✓ ...
- It must allow protection against radiation during transfers
- It must withstand the phenomena of radiolysis and heat release
  - ✓ do not swell, deform, or explode
  - ✓ allow valves to be opened even in the event of a rise in pressure or a rise in temperature
  - ✓ ...
2 – Inactive tests
3 kinds of inactive tests:

- Tests to validate the design
  - leak test
  - drop test
  - crushing test
  - pressure resistance test
  - temperature resistance test
  - ...

- Tests to validate the manufacture
  - verification of conformity of materials used
  - weld inspection
  - dimensional inspection

- Tests to validate the use in hot cells
  - handling test with master-slave manipulators in different configurations for each transfer step
Inactive tests: examples

Drop test

- **Test objective:** to check in the event of a fall
  - continued containment
  - continued handling possibility
  - continued emptying possibility

- **Conditions for carrying out the test:**
  - 2 drop heights:
    - 1m
    - 5m
  - 4 points of impact:
    - the protective crown
    - the handle
    - the bottom
    - the body
Inactive tests: examples

**Drop test**

- **Test result:**
  - improvement of the protective crown
  - slight deformations, but meet safety requirements
Crushing test

- **Test objective:** to check that deformations do not lead to
  - loss of containment
  - blocking of secured bottle in the container
  - impossibility of opening valves

- **Conditions for carrying out the test:**
  - load to be applied: 750 kg
  - contact surface: 60 mm x 60 mm

- **Test result:**
  - ✓ Acceptable deformations
Inactive tests: examples

Pressure resistance test

- **Test objective:**
  - to record deformations of the secured bottle in case of pressure rise
  - to find the pressure limit that lead to explosion of the secured bottle

- **Conditions for carrying out the test:**
  - Pressure applied: from 0 to 200 bar

- **Test result:**
  - no leak, no explosion until 200 bar
  - permanent deformations
Temperature resistance test

- **Test objective:** to check that valves can be opened in case of temperature increase
- **Conditions for carrying out the test:**
  - Temperature applied: from 25°C to 125°C
- **Test result:**
  - No difficulty for opening valves
3 – Safety file and NSA authorization
Contents of the safety file:
- Demonstration of nuclear safety for each risk
- Test program and reports
- Radiation safety calculation note

Radiolysis and heat release:
- Limited filling rate (from 6% to 98% depending on effluent)
- Continuous transfer process (< 10 hours between closing and opening of the valve)
- Preliminary verification of availability of the equipment needed for transfer

Time scale:
- 1 year to prepare the safety file
- 1 year of exchange with the Nuclear Safety Authority
4 – Commissioning in hot cells
Transfer from an other shielded line

Handling accessories
Commissioning in hot cells

Handling the secured bottle from a hot cell to another in a shielded line
Opening valves

Filling the secured bottle
Thank you for your attention